## **CLAIMS**

What is claimed is:

An apparatus for separating signals from a wavelength multiplexed signal, the apparatus comprising:

an optical circulator having a first port positioned and arranged to receive the wavelength multiplexed signal, a second port positioned and arranged to output the wavelength multiplexed signal, and a third port positioned and arranged to output signals input at the second port;

an optical pump optically coupled to the second port;

- a fiber amplifier optically coupled to the optical pump; and
- a spectrally selective reflecting grating optically coupled to the fiber amplifier.
- 2. An apparatus as in claim 1, wherein the fiber amplifier comprises an erbium doped fiber amplifier.
- 3. An apparatus as in claim 2, wherein the optical pump further comprises the erbium doped fiber amplifier.
- 25 4. An apparatus as in claim 1, wherein the spectrally selective reflecting grating is a fiber Bragg grating.
  - 5. An apparatus as in claim 4, wherein the fiber Bragg grating is integrally built in with the fiber amplifier.

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An apparatus for separating signals from a wavelength multiplexed signal, the apparatus comprising:

an optical circulator having a first port positioned and arranged to receive an optical pump input, a second port positioned and arranged to output signal received from the first port and to receive the wavelength multiplexed signal through a fiber amplifier, a third port positioned and arranged to output signals input at the second port and receiving input signals, and a fourth port positioned and arranged to output signals input at the third port;

an optical pump optically coupled to the first port;

the fiber amplifier optically coupled to the second port; and

a spectrally selective reflecting grating optically coupled to the third port.

- 7. An apparatus as in claim 6, wherein the optical pump is optically coupled to the first port.
- 8. An apparatus as in claim 6, wherein the fiber amplifier is an erbium doped fiber amplifier.
- 9. An apparatus as in claim 8, wherein the erbium doped fiber amplifier is integrally built in at the second port.
- 10. An apparatus as in claim 6, wherein the spectrally selective reflecting grating is a fiber Bragg grating.
- 11. An apparatus as in claim 10, wherein the fiber Bragg grating is integrally built in at the third port.

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12. A system for separating signals from a wavelength multiplexed signal using an optical circulator, said optical circulator having a first port positioned and arranged to receive the wavelength multiplexed signal, a second port positioned and arranged to output the wavelength multiplexed signal and receiving input signals, and a third port positioned and arranged to output signals input at the second port, the system comprising:

means for receiving the wavelength multiplexed signal from the second port;

means for amplifying the wavelength multiplexed signal, wherein an amplified signal results; and

means for reflecting a component of the amplified signal, said component having a selected wavelength, into the second port, wherein the component exits through the third port.

- 13. A system as in claim 12, wherein said means for amplifying the wavelength multiplexed signal comprises means for optically pumping the wavelength multiplexed signal in a doped fiber amplifier attached to the second port.
- 14. A system as in claim 13, wherein said doped fiber amplifier comprises an erbium doped fiber amplifier.
- 15. A system as in claim 12, further comprising means for applying the amplified signal to a fiber Bragg grating, wherein the component of the amplified signal reflects back into the second port.

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A system for separating optical signals from a wavelength multiplexed signal using an optical circulator, said optical circulator having a first port positioned and arranged to receive an optical pump input, a second port positioned and arranged to output signal received from the first port and to receive the wavelength multiplexed signal through a fiber amplifier, a third port positioned and arranged to output signals input at the second port and receiving input signals, and a fourth port positioned and arranged to output signals input at the third port, the system comprising:

means for amplifying and receiving the wavelength multiplexed signal in the second port, wherein an amplified signal results;

means for outputting the amplified signal from the third port; and

means for reflecting a component of the amplified signal, said component having a selected wavelength, into the third port, wherein the component exits through the fourth port.

- 17. A system as in claim 16, wherein said means for amplifying the wavelength multiplexed signal comprises means for optically pumping the wavelength multiplexed signal in a doped fiber amplifier attached to the second port.
- 18. A system as in claim 17, wherein said doped fiber amplifier comprises an erbium doped fiber amplifier.
- 25 19. A system as in claim 17, wherein the optical pumping is performed using an optical pump attached to the first port.
  - 20. A system as in claim 19, further comprising means for applying the amplified signal to a fiber Bragg grating, wherein the component of the amplified signal reflects back into the third port.

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1. A method of separating signals from a wavelength multiplexed signal using an optical circulator, said optical circulator having a first port positioned and arranged to receive the wavelength multiplexed signal, a second port positioned and arranged to output the wavelength multiplexed signal and receiving input signals, and a third port positioned and arranged to output signals input at the second port, the method comprising:

receiving the wavelength multiplexed signal from the second port;

amplifying the wavelength multiplexed signal, wherein an amplified signal results; and reflecting a component of the amplified signal, said component having a selected wavelength, into the second port, wherein the component exits through the third port.

- 22. A method as in claim 21, wherein said amplifying the wavelength multiplexed signal comprises optically pumping the wavelength multiplexed signal in a doped fiber amplifier attached to the second port.
- 23. A method as in claim 22, wherein said doped fiber amplifier comprises an erbium doped fiber amplifier.
- 24. A method as in claim 21, further comprising applying the amplified signal to a fiber Bragg grating, wherein the component of the amplified signal reflects back into the second port.

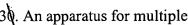
A method of separating optical signals from a wavelength multiplexed signal using an optical circulator, said optical circulator having a first port positioned and arranged to receive an optical pump input, a second port positioned and arranged to output signal received from the first port and to receive the wavelength multiplexed signal through an optical pump, a third port positioned and arranged to output signals input at the second port and receiving input signals, and a fourth port positioned and arranged to output signals input at the third port, the method comprising:

amplifying and receiving the wavelength multiplexed signal in the second port, wherein an amplified signal results;

outputting the amplified signal from the third port; and

reflecting a component of the amplified signal, said component having a selected wavelength, into the third port, wherein the component exits through the fourth port.

- 26. A method as in claim 25, wherein said amplifying the wavelength multiplexed signal comprises optically pumping the wavelength multiplexed signal in a doped fiber amplifier attached to the second port.
- 27. A method as in claim 26, wherein said doped fiber amplifier comprises an erbium doped fiber amplifier.
- 28. A method as in claim 26, wherein the optical pumping is performed using an optical pump attached to the first port.
  - 29. A method as in claim 25, further comprising applying the amplified signal to a fiber Bragg grating, wherein the component of the amplified signal reflects back into the third port.



30. An apparatus for multiplexing optical signals, the apparatus comprising:

an optical circulator having a first port positioned and arranged to receive a first signal, a second port positioned and arranged to output the first signal and receive input signals, and a third port positioned and arranged to output signals input at the second port;

an optical pump optically coupled to the second port;

a fiber amplifier optically coupled to the optical pump; and

a spectrally selective reflecting grating optically coupled to the fiber amplifier.

- 31. An apparatus as in claim 30, wherein the fiber amplifier comprises an erbium doped fiber amplifier.
- 32. An apparatus as in claim 31, wherein the optical pump further comprises the erbium doped fiber amplifier.
- 33. An apparatus as in claim 30, wherein the spectrally selective reflecting grating is a fiber Bragg grating.
- 34. An apparatus as in claim 33, wherein the fiber Bragg grating is integrally built in with the fiber amplifier.

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35. An apparatus for multiplexing optical signals, the apparatus comprising:

an optical circulator having a first port positioned and arranged to receive an optical pump input, a second port positioned and arranged to receive the optical pump input and receive an input signal, a third port positioned and arranged to output signals input at the second port and receive input signals, and a fourth port positioned and arranged to output signals input at the third port;

- a first spectrally selective reflecting grating to reflect the optical pump input optically coupled to the second port;
- a fiber amplifier optically coupled to the third port; and
- a second spectrally selective reflecting grating, to reflect the signal input in the second port, optically coupled to the fiber amplifier.
- 36. An apparatus as in claim 35, wherein the optical pump is optically coupled to the first port.
- 37. An apparatus as in claim 35, wherein the fiber amplifier is an erbium doped fiber amplifier.
- 38. An apparatus as in claim 37, wherein the erbium doped fiber amplifier is integrally built in at the third port.
- 39. An apparatus as in claim 35, wherein the first spectrally selective reflecting grating and the second spectrally selective reflecting grating are fiber Bragg gratings. 25

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40. A system for multiplexing optical signals using an optical circulator having a first port positioned and arranged to receive a first signal, a second port positioned and arranged to output the first signal and receive input signals, and a third port positioned and arranged to output signals input at the second port, the system comprising:

means for receiving the first signal from the second port;

means for amplifying the first signal, wherein an amplified first amplified signal results; means for reflecting the first amplified signal back into the second port; means for amplifying a second signal, wherein a second amplified signal results; means for inputting the amplified second signal into the second port; and

41. A system as in claim 40, wherein said means for amplifying the first signal, and said means for amplifying the second signal comprise means for optically gaining the first signal in a doped fiber amplifier attached to the second port, and means for optically gaining the second signal in a doped fiber amplifier attached to the second port.

means for outputting a multiplexed signal through the third port.

- 42. A system as in claim 41, wherein said doped fiber amplifier comprises an erbium doped fiber amplifier.
- 43. A system as in claim 40, wherein the means for reflecting the first signal comprises a spectrally selective reflecting grating.
- 44. A system as in claim 43, wherein the spectrally selective reflecting grating comprises a fiber Bragg grating.

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A system of multiplexing optical signals using an optical circulator having a first port positioned and arranged to receive an optical pump input, a second port positioned and arranged to receive the optical pump input and receive a first signal, a third port positioned and arranged to output signals input at the second port and receive input signals, and a fourth port positioned and arranged to output signals input at the third port, the system comprising:

means for receiving the first signal from the third port;

means for amplifying the first signal, wherein an amplified first signal results;

means for reflecting the first signal back into the third port;

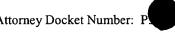
means for amplifying a second signal, wherein an amplified second signal results;

means for inputting the second signal into the third port; and

means for outputting a multiplexed signal through the fourth port.

- 46. A system as in claim 45, wherein said means for amplifying the first signal, and said means for amplifying the second signal comprise means for optically gaining the first signal in a doped fiber amplifier attached to the third port, and means for optically gaining the second signal in the doped fiber amplifier attached to the third port.
- 47. A system as in claim 46, wherein said doped fiber amplifier comprises an erbium doped fiber amplifier.
  - 48. A system as in claim 45, wherein the means for reflecting the first signal comprises a spectrally selective reflecting grating.
- 30 49. A system as in claim 48, wherein the spectrally selective reflecting grating comprises a fiber Bragg grating.

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50. A method of multiplexing optical signals using an optical circulator having a first port positioned and arranged to receive a first signal, a second port positioned and arranged to output the first signal and receive input signals, and a third port positioned and arranged to output signals input at the second port, the method comprising:

receiving the first signal from the second port;

amplifying the first signal, wherein an amplified first signal results;

reflecting the amplified signal back into the second port;

amplifying a second signal, wherein an amplified second signal results;

inputting the amplified second signal into the second port; and

outputting a multiplexed signal through the third port.

- 51. A method as in claim 50, wherein said amplifying the first signal, and said amplifying the second signal comprise optically gaining the first signal in a doped fiber amplifier attached to the second port, and optically gaining the second signal in a doped fiber amplifier attached to the second port.
- 52. A method as in claim 51, wherein said doped fiber amplifier comprises an erbium doped fiber amplifier.
- 53. A method as in claim 50, wherein the reflecting the first signal comprises reflecting the first signal from a spectrally selective reflecting grating.
- 54. A method as in claim 53, wherein the spectrally selective reflecting grating comprises a fiber 30 Bragg grating.

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56. A method of multiplexing optical signals using an optical circulator having a first port positioned and arranged to receive an optical pump input, a second port positioned and arranged to receive the optical pump input and receive a first signal, a third port positioned and arranged to output signals input at the second port and receive input signals, and a fourth port positioned and arranged to output signals input at the third port, the method comprising:

receiving the first signal from the third port;

amplifying the first signal, wherein an amplified first signal results;

reflecting the first signal back into the third port;

amplifying a second signal, wherein an amplified second signal results;

inputting the second signal into the third port; and

outputting a multiplexed signal through the fourth port.

- 56. A method as in claim 55, wherein said amplifying the first signal, and said amplifying the second signal comprise optically gaining the first signal in a doped fiber amplifier attached to the third port, and optically gaining the second signal in a doped fiber amplifier attached to the third port.
- 57. A method as in claim 46, wherein said doped fiber amplifier comprises an erbium doped fiber amplifier.
- 58. A method as in claim 45, wherein the reflecting the first signal comprises reflecting the first signal from a spectrally selective reflecting grating.
- 59. A method as in claim 48, wherein the spectrally selective reflecting grating comprises a fiber 30 Bragg grating.